

## **FUEL TANK FILLER NECK AND METHOD OF MANUFACTURING SAME**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

5 This application is a continuation-in-part of U.S. application Serial  
No. 09/454,103 filed December 3, 2000.

### **TECHNICAL FIELD**

The present invention relates to the fuel tank filler neck connected to the gas tank of an automobile.

### **BACKGROUND ART**

10 Gas tank fuel systems with reduced gasoline vapor loss are becoming increasingly important in the automobile industry to reduce needless loss of fuel. The typical solution to this problem has been to reduce the diameter of at least a section of the fuel tank filler neck. Though this approach has been somewhat successful, it is limited because as the diameter of the filler neck is decreased, the  
15 resistance to flow of the gasoline is increased. The increased resistance causes the fill neck to become filled during vehicle refueling thereby blocking release of any pressure buildup and causing the fuel nozzle to shut off prematurely before the fuel tank is full. Another consideration in preventing the loss of fuel, is the permeability of the materials from which the fuel tank system is made. Fuel vapors escape by  
20 diffusing through the various types of mild steels of which components of fuel tank systems are typically made. This fuel escape is particularly apparent after the mild steel components have corroded to any degree.

Another disadvantage of the current methods of reducing gasoline vapor losses is that typically the end of the gas line filler neck is flared out in order  
25 to provide a sufficient diameter to accept the gas nozzle during refueling. These filler

necks are often made by a process of repeated reductions and expansions of a seamed welded tube. Accordingly, there is an increasing tendency for the integrity of the weld to leak as thinner diameter tubes are utilized.

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## DISCLOSURE OF INVENTION

The filler neck for receiving a fuel supply nozzle for a motor vehicle fuel tank includes a one-piece seamless funnel member having a tubular body. The funnel member defines in off-set axial relation a relatively large inlet opening adapted for attachment to a receptor for the nozzle and a relatively small necked down outlet opening adapted for attachment to the inlet of an elongated tubular member in communication with the fuel tank. The offset relationship of the inlet and outlet opening induces a swirling motion in the fuel flow as the fuel proceeds towards the fuel tank. The resultant swirl motion of the flowing fuel leaves an opening through which any pressure buildup in the fuel tank may be vented. The spiraling motion of the fuel through the narrow elongated tube member also assists in preventing fuel vapors from escaping during refueling because of an induced suctioning effect that is created by the spiraling motion of the fuel through a narrow cavity.

In another embodiment of the invention, the seamless funnel member is drawn and provided with an attachment portion adjacent to the inlet opening for attaching a gas nozzle receptor to the funnel member. The seamless surface of the filler neck allows for the receptor to protrude into the filler neck and form a seal to the inner surface of the filler neck.

In still another embodiment of the invention, the seamless funnel member is attached to the elongated member inlet by either a braised joint, an adhesive joint, or a resistance welded joint.

In yet another embodiment of the invention, the seamless filler neck is provided with an anti-corrosive coating.

In the preferred embodiment of the invention, the relatively large diameter section forming the inlet opening into which the gas nozzle is positioned and a spaced-apart relatively smaller diameter tubular section forming the outlet opening are in an axially offset relationship. These tubular sections are connected to one another by a tapered section which gradually blends from the large diameter section to the small diameter section. In a refinement of this embodiment, the tapered section intersects the large diameter section at an elliptically-shaped junction which lies in a plane inclined  $60-85^\circ$  from the axis of the tubular sections. In a further refinement of this embodiment, the funnel inlet opening has a diameter  $D_1$  and the tubular section has a diameter  $D_2$  with a coaxial offset at a distance  $X$  where  $.1D_2$  is less than  $X$  which is less than  $.3D_2$ , and where  $D_1$  is at least one and a half times  $D_2$ . In yet another refinement of this embodiment of the invention, the funnel inlet axial offset is sufficient to achieve fuel swirl during fuel filling.

In another embodiment of the invention, the funnel inlet opening has a diameter  $D-1$  and the outlet opening has a diameter  $D-2$  where  $D-1$  is at least one and a half times  $D-2$ . In a refinement of this embodiment,  $D_2$  is less than 35 mm. In a further refinement of this embodiment,  $D_2$  is less than 30 mm.

This invention also includes a method of manufacturing the filler neck for a motor vehicle fuel tank. First, the filler neck is formed by deep-drawing a seamless funnel member having an elongated tubular body with an enlarged inlet at one end and a relatively small outlet at the opposite end. A length of butt-seam tubing is cut to form a tubular member of desired length. An end of the tubular member is telescopically aligned with the outlet of the funnel member to securely join the funnel and tubular members together. The tubular member is bent to a desired shape. A nozzle receptor is attached to the funnel member adjacent the funnel inlet. In a refinement of the method, the configuration is then leak tested to verify the integrity of joining the funnel member to the tubular member and the attachment of the nozzle receptor to the funnel member, and the integrity of the butt-seam joint and the tubular member subsequent to bending. The funnel member is attached to the tubular member by braising, adhesive bonding, or welding. In yet another refinement of the method, a portion of the filler neck is configured to induce a sufficient swirl to create

a hollow passage for suctioning fuel vapors to prevent their escape during refueling and to provide a vent passage for any pressure buildup in the fuel tank.

Accordingly, it is an object of the present invention to provide an improved fuel tank filler neck.

5                   Another object of the present invention is to provide an improved fuel tank filler neck that inhibits the escape of gasoline vapors from the fuel tank.

Still another object of the present invention is to provide an improved fuel tank filler neck that is inexpensive to fabricate.

10                   Still another object of the present invention is to provide an improved fuel tank filler neck that vents pressure buildup created in the fuel tank during refueling.

Still another object of the present invention is to provide an improved fuel tank filler neck that does not leak.

15                   Yet another object of the present invention is to provide an improved method for fabricating the fuel tank filler neck of the foregoing objects.

20                   Another more specific object of the invention is a method for forming a filler neck for a motor vehicle fuel tank by deep-drawing a seamless funnel member having an elongated tubular body with an enlarged inlet at one end and a relatively small outlet at the opposite end. A length of butt-seam tubing is cut to form a tubular member of desired length. An end of the tubular member is telescopically aligned with the outlet of the funnel member and securely joining the funnel and tubular members together. The tubular member is bent to a desired shape. A nozzle receptor is attached to the funnel member adjacent the funnel inlet.

Another more specific object in the method of the last mentioned object includes a portion of the filler neck configured to induce a sufficient swirl to create a hollow passage for venting vapors from the gas tank during fuel filling.

5 In carrying out the above objects and other objects and features of the present invention, a fuel tank filler neck is described in a mounting relationship to the vehicle fuel tank. The fuel tank filler neck and the method for its manufacture provide advantages to an automobile manufacturer by reducing escape of gasoline vapors from the fuel tank, by permitting simple manufacturing of the filler neck, and by reducing attendant costs.

10 The above objects and other objects, features, and advantages of the present invention are readily apparent from the following detailed description of the best mode for carrying out the invention when taken in connection with the accompanying drawings.

#### **BRIEF DESCRIPTION OF DRAWINGS**

15 FIGURE 1 is a schematic of a fuel tank filler neck incorporated in a automobile fuel tank system;

FIGURE 2 is a fragmented cross sectional view of the fuel tank filler neck and an attached elongated member in the fuel tank system of Figure 1 according to one embodiment of the present invention;

20 FIGURE 3 is a schematic dimensional view of the filler neck as a funnel member according to an embodiment of the present invention;

FIGURE 4 is a cross sectional view of a rolled over top modification of the fuel tank filler neck according to another embodiment of the present invention;

FIGURE 5 is a cross sectional view of a barbed end design of the fuel tank filler neck according to another embodiment of the present invention;

FIGURE 6 is a cross sectional view of a hose bead modification of the fuel tank filler neck according to another embodiment of the present invention; and

5                   FIGURES 7a-7i are schematic illustrations of the method steps for making the fuel tank filler neck of this invention.

**BEST MODE FOR CARRYING OUT THE INVENTION**

**ARTICLE**

10                   With reference to Figure 1 a schematic of an embodiment of fuel tank filler neck 2 incorporated into automobile fuel tank system 4 is provided. Filler neck 2 for receiving fuel nozzle 6 for a motor vehicle fuel tank includes a one-piece funnel member 8 having a tubular body. One piece funnel member 8 may be made of a number of types of metals, suitable materials include but are not limited to cold rolled steel, zinc nickel, zinc galvanized, 304 stainless steel, 409 stainless steel, terne plate, tin plate, nickel plate, galvaneal, and aluminum. Funnel member 8 may also be made from injection molded plastics. Suitable injection molded plastics include, but are not limited to Acetal (25% glass fiber), PPH(40% glass fiber), Nylon 66(33% glass fiber), Liquid Crystal Polymer (50% glass fiber) and Nylon 66(60% glass ceramic fiber). The various grades of stainless steel are more desirable in that such materials are more efficient in preventing gasoline vapors from escaping into the environment. One end of funnel member 8 is defined by inlet opening 10 which is attached to nozzle receptor 12. Gas cap 14 screws directly into nozzle receptor 12. Fuel tank system 4 attaches to automobile body 16 through opening 18. Movable cover 20 conceals gas cap 14 when the vehicle is not being refueled. The other end of funnel member 8 is defined by outlet opening 22 that is attached to elongated tube member 24. Elongated tube member 24 attaches to fuel tank 26. During refueling gas cap 14 is removed and gas nozzle 6 is inserted into nozzle receptor 12. Fuel flows out of gas nozzle 6 into funnel member 8. Funnel member 8 induces a swirling

motion in the fuel as the fuel proceeds to flow into elongated tube member 24. The  
 swirling motion of the fuel continues as the fuel fills fuel tank 26. The swirling  
 motion of the fuel created by funnel member 8, creates a suctioning effect that  
 prevents fuel vapors from escaping into the atmosphere during refueling. The  
 5 swirling motion of the fuel, also creates a central void that allows any pressure  
 buildups created during refueling to vent thereby preventing premature shutoff of the  
 fuel nozzle. Vent tube 25 connects to funnel member 8 at funnel vent hole 27 and  
 to fuel tank 26 at fuel tank hole 29. Vent tube 27 allows displaced vapors in fuel  
 tank 26 to be vented during refueling. The venting configuration defined by vent  
 10 tube 27 may be replaced by a system that recirculates the fuel vapor. Such system  
 are known to individuals skilled in the art.

With reference to Figures 1 and 2, funnel member 8 defines in off-set  
 axial relation a relatively large inlet opening 10 adapted for attachment to a gas  
 nozzle receptor 12 and a relatively small necked down outlet opening 22 adapted for  
 15 attachment to inlet 28 of elongated tubular member 24. The off-set axial relation  
 between the inlet opening 10 and outlet opening 22 causes fuel emerging from gas  
 nozzle 6 to impinge on side 30 of funnel member 8 and thereby causes fuel to spiral  
 as the fuel proceeds forward to elongated tube member 24. Gas cap 14 screws  
 directly into gas nozzle receptor 6. Filler neck 2 may optionally be provided with  
 20 vent opening 27 for attachment to vent tube 25. Vent opening 27 may either be  
 drilled in funnel member 8 after it drawn or it may be incorporated in the sheet stock  
 before funnel member 8 is drawn. Funnel member 8 is drawn and is therefore  
 seamless. Funnel member 8 is provided with an cutouts 30, 32 adjacent to inlet  
 opening 10 for attaching the nozzle receptor 6 to funnel member 8. Cutouts 30,32  
 25 allow nozzle receptor 6 to snap into position via wings 34, 36 that protrude out of  
 nozzle receptor 6. Because funnel member 8 is seamless, insert section 38 of nozzle  
 receptor 6 is able to make intimate contact with funnel member 8 thereby creating  
 a leak-proof seal via O-ring 40. Funnel member 8 is attached to the elongated  
 member inlet 28 by braised joint 42. Optionally, filler neck 2 may be coated with  
 30 an anti-corrosive coating 44.

## 7. Preliminary Amendment:

- a. ☐ A Preliminary Amendment is attached.
- b. ☐ Cancel in this application original claims \_\_\_\_\_ of the prior application before calculating the filing fee.
- c. ☐ Please amend the specification by inserting before the first line the following sentence:  
       "This is a \_\_\_\_\_ continuation \_\_\_\_\_ divisional of copending  
       application(s) serial number \_\_\_\_\_ / \_\_\_\_\_ filed on \_\_\_\_\_."
- d. ☐ A Petition to Suspend Prosecution For The Time Necessary to File An Amendment (New Application Filed Concurrently) is attached.

## 8. Small entity status:

- a. ☐ Applicant claims small entity status.
- b. ☒ Small entity status was claimed in the prior nonprovisional application and such status is still proper and desired.
- c. ☐ Is no longer desired.

## 9. Fee Calculation:

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS (37 C.F.R. § 1.16(c))	30 -20 =	10	x 18.00	180.00
INDEPENDENT CLAIMS (37 C.F.R. § 1.16(b))	3 -3 =	0	x 84.00	0.00
MULTIPLE DEPENDENT CLAIMS (if applicable) (37 C.F.R. §1.16(d))			280.00	
BASIC FEE (37 C.F.R. § 1.16(a))				740.00
TOTAL OF ABOVE CALCULATIONS				920.00
REDUCTION BY 50% FOR FILING BY SMALL ENTITY (NOTE 37 C.F.R. §§ 1.9, 1.27, 1.28)				460.00
\$40.00 ASSIGNMENT RECORDAL FEE (if applicable)				
TOTAL				\$460.00

10. ☒ A check in the amount of \$ 460 is enclosed.
11. ☒ The Commissioner is hereby authorized to credit overpayments or charge the following fees (or any deficiency therein) to Deposit Account No. 02-3978 :
- a. ☒ Fees required under 37 C.F.R. § 1.16.
- b. ☒ Fees required under 37 C.F.R. § 1.17.

## 12. Maintenance of Copendency of Prior Application

☐ A request for extension of time and the appropriate fee have been filed in the pending prior application (or are being filed in the prior application concurrently herewith) to extend the period for response until \_\_\_\_\_.



With reference to Figure 3, relatively large diameter section 46 forming the inlet opening 10 and the spaced-apart relatively smaller diameter tubular section 48 forming the outlet opening 22 are in an axially offset relationship. The large diameter section 46 and the small diameter tubular section 48 are connected to one another by tapered section 50 which gradually blends from the large diameter section 46 to the small diameter section 48. Tapered section 50 intersects large diameter section 46 at elliptically-shaped junction 52 which lies in a plane inclined at angle A which is 60-85° from the axis of the tubular sections. The funnel inlet opening 10 has a diameter  $D_1$  of 60 mm and the tubular section has a diameter  $D_2$  of 25 mm with a coaxial offset at a distance X which is 15 mm. This offset axial relationship is sufficient to achieve fuel swirl during fuel filling.

With reference to Figure 4, a modification of filler neck 2 is illustrated. Rolled over top 54 is formed at the top of large diameter section 46. In this modification, rolled over top 54 provides a sealing surface onto which gas cap 14 makes a seal. Gas cap 14 screws directly into nozzle receptor 12. Nozzle receptor 12 is held in position by crimps 56, 58 which project into indentations 60, 62 in nozzle receptor 12.

With reference to Figure 5, a modification of filler neck 2 is illustrated. The surface of the smaller diameter tubular section 48 is provided with barbs 64, 66, 68. This modification allows for plastic or rubber tubing to be utilized for the formation of elongated tube member 24.

With reference to Figure 6, a modification of filler neck 2 is provided. The surface of the smaller diameter tubular section 48 is provided with hose bead 70. This modification allows for plastic or rubber tubing to be utilized for the formation of elongated tube member 24.

## METHOD

The fuel tank filler neck of this invention may be made by a number of process which includes eyelet/progressive stamping, eyelet stamping, progressive

die stamping, transfer die stamping, and hydroforming. If the fuel tank filler neck is made of plastics, injection molding and compression molding are suitable methods for manufacturing the fuel tank filler neck.

5                   The eyelet/progressive stamping method of manufacturing the fuel tank filler neck of this invention will now be described with reference to Figures 1, 2, 3 and 7. First, the filler neck 2 for motor vehicle fuel tank system 4 is formed by deep-drawing a seamless funnel member 8 having an elongated tubular body 24 with an enlarged inlet opening 10 at one end and a relatively small outlet opening 22 at  
10 the opposite end. A length of butt-seam tubing is cut to form a tubular member 24 of desired length. An end of the tubular member is telescopically aligned with outlet opening 22 of funnel member 8 and securely joining the funnel and tubular members together. Elongated tubular member 24 is bent to a desired shape. Nozzle receptor 12 is attached to funnel member 8 adjacent funnel inlet opening 10. In a refinement  
15 of this embodiment, the configuration is then leak tested to verify the integrity of joining funnel member 8 to tubular member 24 and the attachment of nozzle receptor 12 to funnel member 8, and the integrity of the butt-seam joint 42 and the tubular member 24 subsequent to bending. The funnel member 8 is attached to the tubular member 24 by braising, adhesive bonding, or welding. In yet another refinement of  
20 this embodiment, a portion of the filler neck 2 is configured to induce a sufficient swirl to create a hollow passage for suctioning fuel vapors into the tank 26 and to allow venting of any pressure buildup during in fuel tank 26 during refueling.

                  With reference to Figure 7, schematic illustrations of the method steps for making the fuel tank filler neck of this invention and attaching the elongated tube  
25 member are provided. In step 7a, sheet stock is preformed into a circular blank that is drawn into a funnel shape in step 7b. The ends of the funnel shape are next trimmed in step 7c to remove excess stock and thereby form funnel member 8. In step 7d, pipe stock is cut to desired length to form elongated tube member 24. Elongated tube member 24 is then flared at the ends in step 7i in order to provide an  
30 attachment mechanism to the funnel member. The elongated tube and funnel member are then aligned in step 7f and brazed together in step 7g. The funnel member and

elongated tube combination is then bent in step 7h. Nozzle receptor 12 is then inserted in step 7i.

5 While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.